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sideration the roughness of the time measurements and the many sources of possible variation in the results, their uniformity appears to be significant.

There are two different points of view, at least, from which these facts may be regarded. On the one hand, it may be urged that the stronger the affective tone of a stimulus, the more motor energy it represents; hence we should expect a strong and prompt motor response from very pleasant or very unpleasant stimuli, a weaker one from stimuli of moderate affective tone, and a still weaker one from indifferent stimuli. Nakashima,¹ however, found that reactions involving affective tone take longer than ordinary cognition or discrimination reactions, a result which he ascribes to the lack of clearness as an attribute of affection. If this explanation be accepted it may be argued that extreme degrees of pleasantness and unpleasantness would possess in their intensity a kind of substitute for clearness, and so would give shorter reaction times than moderate degrees, but it might seem that we should be unable to account for the fact that judgments of indifference took regularly longer than judgments of pleasantness and unpleasantness. Of course, though, a judgment of indifference is a very different thing from a cognitive judgment about a stimulus that is as a matter of fact indifferent. In the latter case attention is not directed to the existence or non-existence of an affective tone; in the former case the problem is: Has this stimulus produced an affective experience or has it not?

A largely contributing factor to our results is probably the same law that makes associative reactions to ambiguous words slower than those to *eindeutig* words. The indifference judgments take longest because there are three alternatives more or less present to consciousness, namely, pleasantness, unpleasantness, and indifference; the judgments of moderate pleasantness and unpleasantness take fairly long because the possibility of the opposite judgment or of an indifference judgment still lurks in the background; while the extreme judgments are the shortest because there is no alternative possibility present at all to consciousness. The indifference judgments, further, probably take longer than the judgments of moderate pleasantness and unpleasantness because the Aufgabe involves the discovery if possible of an affective tone, and many observers feel that an indifference judgment means a failure to perform the Aufgabe, despite the fact that the instructions allow it.

The effect of practice rather than fatigue was apparent in most cases when the time of the first thirty reactions was compared with that of the last thirty. In forty-three out of fifty-five cases the last thirty reactions were quicker than the first thirty. Moreover, practice tended to level somewhat the differences between the averages for the different categories of judgment.

XXV. A STUDY OF AFFECTIVE CONTRAST.

By MARGARET M. BACON, ESTHER A. ROOD, and M. F. WASHBURN

The pleasure of an agreeable experience is heightened if it is preceded by a disagreeable experience, and an impression in itself unpleasant may be felt as pleasant if a more unpleasant state has been its antecedent. In like manner unpleasantness may be heightened or

¹ *Psychological Review*, vol. 16, 1909, pp. 303-340; *American Journal of Psychology*, vol. 20, 1909, pp. 157-193.

even created through contrast with a preceding agreeable affective state. These are laws of the affective life which every-day experience has established. We undertook to investigate them under laboratory conditions.

As in the earlier experiments performed in this laboratory on affective processes, our materials were pieces 2.9 cm. square of the ninety Bradley colors. As a preliminary, the entire set of ninety pieces was spread on the table before the observer, who was asked to pick out six colors which seemed to her extremely disagreeable, and six which seemed to her extremely pleasant. These were set aside, the experimenter making a note of their numbers. Eighteen other colors were then chosen by the experimenter, saturated colors, shades, and tints being equally represented. These eighteen colors were shown to the observer, one at a time, on a white ground. Between the showing of each color and that of the next, one of the pleasant colors selected by the observer was shown. As each color was presented, the observer was asked to express her judgment of its pleasantness or unpleasantness by using one of the numbers from 1 to 7 in the usual way. When all of the eighteen colors had been shown, each preceded by one of the very pleasant colors, the experiment was continued without pause and the same eighteen colors were again presented, in a different order, each this time preceded by one of the very unpleasant colors chosen by the observer. Care was taken that the second presentation of a color should not follow its first presentation by so short an interval that the observer would of necessity recall her first judgment of its affective value. If affective contrast exerted a decided influence, the affective values of the colors seen immediately after an unpleasant color ought to be higher than the values of the same colors seen immediately after a pleasant color.

In order to equalize fatigue conditions, with other observers the colors were first presented preceded by the unpleasant colors and later preceded by the pleasant ones.

One of the experimenters (E. A. R.) told her observers that the object of the experiment was to study the influence which the preceding pleasant and unpleasant colors would have upon their judgments of the affective value of the colors, and the observers were acquainted of course with the general facts of affective contrast. The other experimenter (M. M. B.) gave her observers no information whatever about the experiment, and a number of them did not even realize that the same colors were being presented twice. Thus E. A. R. used a method 'with knowledge' and M. M. B. a method 'without knowledge.' This difference was most interestingly influential upon the results.

E. A. R., whose observers worked with knowledge, experimented upon forty-seven persons. In the case of thirty, the unpleasant 'inducing' colors were used first and the pleasant ones second. Affective contrast, if present as an influence, should have brought about a lowering of the affective values of the colors on their second presentation. In the case of five observers, more affective values were lowered on second presentation than were either stationary or raised. In the case of five other observers, more affective values were raised on the second presentation than were either stationary or lowered. The other twenty observers gave the same affective value for the majority of the colors in both presentations. Of these, however, nine had more lowered judgments than raised judgments, six had

more raised than lowered, four had an equal number of judgments raised and lowered, and one had her judgments equally distributed among the 'raised,' 'lowered,' and 'stationary' classes.

Seventeen of E. A. R.'s observers had the pleasant inducing colors presented first and the unpleasant ones second. Affective contrast should here have brought about a raising of affective values on the second presentation of the colors. Seven observers had more judgments raised than either remained stationary or were lowered. Two had more lowered than either were raised or remained stationary. The other eight gave the same affective judgment for both presentations in the case of the majority of the colors, but of these two observers had more values raised than lowered, five had more lowered than raised, and one had an equal number lowered and raised.

In thus appears that no effect of contrast is demonstrable in E. A. R.'s results. Only fourteen out of thirty observers gave more lowered than raised affective judgments on colors presented immediately after very pleasant ones, and only nine out of seventeen observers gave more raised than lowered judgments on colors that were presented immediately after very unpleasant ones.

M. M. B., whose observers worked without knowledge of the purpose of the experiments, obtained strikingly different results. She experimented upon thirty-seven persons. In the case of twelve of these, the unpleasant inducing stimuli were given first and the pleasant ones second. Here affective contrast should bring about a lowering of the affective values assigned the colors on their second presentation as compared with the first. Eleven of the twelve observers had more affective values lowered on the second presentation than were either raised or left unchanged. The figures are impressive. They are as follows: *Observer 1*, 12 colors lowered, 2 raised, 4 unchanged; *observer 2*, 12 colors lowered, none raised, 6 unchanged; *observer 3*, 11 lowered, 1 raised, 6 unchanged; *observer 4*, 16 lowered, none raised, 2 unchanged; *observer 5*, 15 lowered, none raised, 3 unchanged; *observer 6*, 8 lowered, 2 raised, 8 unchanged; *observer 7*, 11 lowered, none raised, 7 unchanged; *observer 8*, 11 lowered, none raised, 7 unchanged; *observer 9*, 18 lowered, none raised and none unchanged; *observer 10*, 13 lowered, none raised, 5 unchanged; *observer 11*, 13 lowered, none raised, 5 unchanged; *observer 12*, 16 lowered, none raised, 2 unchanged.

For the other twenty-five of M. M. B.'s observers, the pleasant inducing stimuli were given first; the effect of affective contrast here should have been to raise the values of the colors on their second presentation. Twelve out of the twenty-five had more affective values raised on the second presentation than were either lowered or left unchanged. Eleven had more unchanged judgments than either raised or lowered judgments, but all of these had more raised than lowered. The other two had more judgments lowered than were either raised or left unchanged.

These results certainly demonstrate the influence of affective contrast. Every observer who had the colors presented first after unpleasant and later after pleasant colors had more affective values lowered than raised by the process; twenty-three out of twenty-five observers to whom the colors were shown first after pleasant and later after unpleasant colors had more affective judgments raised than lowered on the second presentation.

That this contrast effect showed itself strikingly only in those observers who were working without knowledge that it might be

looked for is a fact more interesting than the contrast influence itself. The knowledge that one might be expected to find a color unusually agreeable if one had just seen a very disagreeable color, or *vice versa*, instead of aiding the natural contrast influence by the force of positive suggestion, seems merely to have confused and obliterated it. Whether this was because the observers resisted the suggestion we cannot say, without introspective data which could not in the nature of the case have been furnished. Suggestion does have a positive influence on the pleasantness and unpleasantness of colors, even when it is given in the form of direct verbal suggestion, which is most apt to stir up opposition. It seems, however, that affective reactions are so delicately adjusted that we cannot merely add one positive influence to another and look for a summation of effects. The factor of affective contrast is most strongly operative when the affective judgments are made on the bare sense impressions, without any extraneous influence.

XXVI. THE CORRELATION BETWEEN ACCURACY OF THE VISUAL MEMORY AFTER-IMAGE AND CONTROL OF VISUAL IMAGERY

By HELEN ADLER, MYRA WILLIAMS, and M. F. WASHBURN

We have long outgrown the idea that individuals can be classed simply as belonging to the auditory-motor, visual, mixed, *etc.* types, as regards their mental imagery. We know that a person may habitually make use of one kind of imagery, and yet be capable of extremely vivid imagery of another kind under certain circumstances: that is, we realize that the frequency with which a certain modality of imagery is used is not necessarily correlated with the intensity which it is capable of reaching in the mind of the same observer. In the same way, intensity and accuracy of imagery are not necessarily connected. An individual characteristic of great practical importance is the power to control visual imagery. Anyone who has to *think* in terms of visual space, the geometrician, the astronomer, the engineer, needs the power of shifting the parts of his visual images and making them take up new relations to each other, of moving them about in his mind without distorting the spatial relations which the actual objects would maintain if they were physically moved about. How far does ability to control visual imagery correlate itself with other characters such as frequency, intensity, and accuracy of visual imagery?

The present study attempts to study the correlation between ability to control the spatial relations of the parts of a visual image, with ability to reproduce accurately a complex visual image just seen. We shall refer to these characters briefly as 'control' and 'accuracy,' of course they are very special kinds of control and accuracy. Our measure of accuracy was obtained in the following way. We prepared a set of ten cards 8 cm. square. Each card was divided by ruled lines into four equal compartments, and in each compartment a different 'nonsense figure' of eight straight lines was drawn with red ink. Each of these cards was laid in turn on the table before the observer, who sat with closed eyes, and at a signal she opened her eyes and looked at the card for ten seconds. The card was then removed and the observer drew on a blank diagram as much as she could remember of the figures on the card. The same procedure was followed with the other nine cards. The problem of satisfactorily evaluating the results in terms of accuracy is not an easy one.